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The Effect of Land Use and Management on Erosion

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THE EFFECT OF LAND USE AND MANAGEMENT ON EROSION[1]

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PURPOSE OF STUDY

During the past few years there has been an increased interest in the subject of soil erosion. Attention has been given to the causes of erosion and the methods of control. The purpose of this study was to determine in a limited area some of the factors within the control of man which had contributed to erosion. It was hoped that the findings would help answer the question: Why do we find farms with similar soil type and topography under similar climatic conditions varying in degree of erosion?

Soil type, topography, and climate all affect soil erosion. Some soils, because of their texture, structure, or character of subsoil, erode much more readily than others. Other factors being equal, soils on long and steep slopes erode more rapidly than those on short and gentle slopes. Climatic factors, especially the amount and intensity of rainfall, affect erosion. These factors are beyond the control of man. However, it is possible by employing proper methods or practices to do much to counteract the harmful influences of these factors and reduce the rate of soil loss. Some farmers have been much more successful in controlling erosion than have others with the same soil type and slope and similar climatic conditions.

DESCRIPTION OF AREAS

This report is based upon a study of 100 farms located in four Soil Conservation Service demonstration project areas in the State of Ohio (Fig. 1). The Salt Creek area is located in the east central part of Muskingum County with headquarters at Zanesville and consists of approximately 93,000 acres. The Muddy Fork area, located in the western part of Wayne, and the eastern part of Ashland County, has headquarters at Wooster and consists of approximately 33,000 acres. The Granny-Dry Creek area is located in the western part of Knox County with a small portion in the southeastern part of Morrow County, has its headquarters at Mt. Vernon, and consists of approximately 30,500 acres. The Indian Creek area is located in the western part of Butler County with headquarters at Hamilton and consists of approximately 27,800 acres. The Salt Creek area was designated by the Soil Conservation Service as a demonstration area in the spring of 1934. Each of the other areas was established in the late summer of 1935. Hereafter in this study these areas will be referred to by the names of the towns in which their headquarters are located.

The topography of the Zanesville area is rough and broken with relatively short, steep slopes. Only about 12 per cent of the land has slopes of less than 5 per cent, approximately 60 per cent has slopes ranging from 5 to 20 per cent,

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[1]This study was a joint project with Region 3 of the Soil Conservation Service.

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[3]The field work and most of the tabulation of data were done by R. M. Isler of the Ohio Agricultural Experiment Station and Isaac Sheppard of the Soil Conservation Service.

and 26 per cent has slopes of 20 per cent or over. The maximum range in elevation is about 300 feet; most of the land falls within a range in elevation of 150 feet. The predominant soil types are Muskingum and Zanesville silt loams, and there are smaller amounts of Westmoreland, Brooke, Meigs, Tilsit, and others. The average farm consists of about 140 acres, 31 per cent of which is in crops, 54 per cent in open pasture, and 13 per cent in woods, most of which is pastured. Approximately one-fourth of the cropland is devoted to corn; one-fourth, to small grains; and one-half, to meadow. Eighty per cent of the cash receipts is from livestock products and only about 6 per cent, from crops. Dairy products constitute the chief source of livestock income, followed by poultry and eggs, sheep and wool, and beef cattle. The average family labor earnings in 1934 were $527, according to a farm management survey conducted by the Soil Conservation Service.

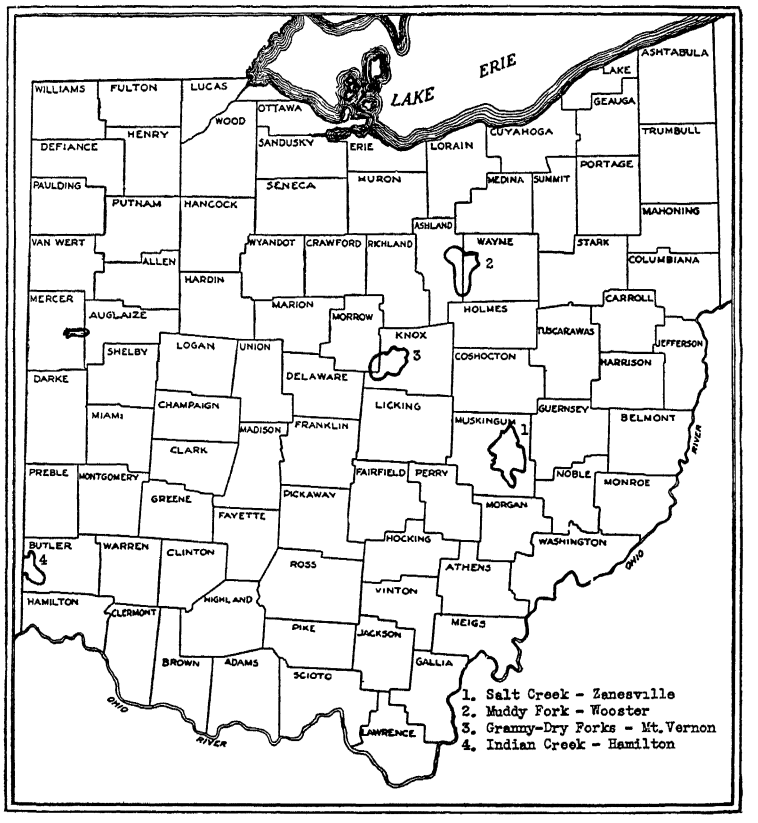

Fig. 1.—Location of Soil Conservation Service demonstration project areas in Ohio

The topography of the Wooster area is undulating to hilly, with many relatively long, gradual slopes and some shorter, steep slopes. About 20 per cent of the area has slopes of less than 3 per cent, 70 per cent has slopes of 3 to 15 per cent, and 10 per cent has slopes of 15 per cent or over. The maximum

range in elevation is about 200 feet, and most of the land falls within a range in elevation of 100 feet. The predominant soil types are Ellsworth and Rittman silt loams, and there are smaller amounts of Braceville, Mahoning, Medina, Trumbull, Wooster, and others. The average farm consists of about 125 acres, 57 per cent of which is in crops, 27 per cent in open pasture, and 10 per cent in woods, over half of which is pastured. Approximately 30 per cent of the cropland is in corn; 45 per cent, in small grains; and 30 per cent, in meadow. About 60 per cent of the cash receipts is from livestock and livestock products and 25 per cent, from crops. Wheat constitutes most of the crop sales; dairy and poultry products constitute the bulk of the livestock receipts. The average family labor earnings in 1935 were $1006, according to the farm management survey.

The topography of the Mt. Vernon area is undulating and broken with many relatively short steep slopes. About 20 per cent of the area has slopes of less than 3 per cent, 60 per cent has slopes ranging from 3 to 12 per cent, and about 20 per cent has slopes of 12 per cent or over. There is a range in elevation of about 200 feet, but most of the land is within a range in elevation of 100 feet. About 65 per cent of the soils are Cardington and Rittman silt loams, but there are smaller amounts of Bennington, Medina, Wooster, Wayne, and Huntington silt loams. The average farm consists of about 150 acres, about 42 per cent of which is in crops, 41 per cent in open pasture, and 13 per cent in woods, over half of which is pastured. Approximately one-third of the crop area is devoted to corn; one-third, to small grains; and one-third, to meadow. About 85 per cent of the cash receipts is from livestock and livestock products and only 10 per cent, from crops. Dairy and poultry products constitute the chief sources of livestock receipts; sheep and wool, and beef cattle rank third and fourth, respectively. The average family labor earnings in 1935 were $1061, according to the farm management survey.

The topography of the Hamilton area is gently rolling to hilly, with some bottom land and many long, gradual slopes. Approximately 30 per cent of the area has slopes of less than 3 per cent; 60 per cent has slopes of from 3 to 15 per cent; and 10 per cent has slopes of 15 per cent or over. The range in elevation is about the same as that in the Mt. Vernon area. About 70 to 75 per cent of the soil is Russell and Fincastle, and there are lesser amounts of Fairmont, Milton, Fox, Brookston, Delmar, Genessee, and others. The average farm consists of about 155 acres, 60 per cent of which is in crops, 19 per cent in open pasture, and 13 per cent in woods, most of which is pastured. About 40 per cent of the cropland is in corn; 32 per cent, in small grains; 17 per cent, in meadow; and 11 per cent, in other crops, including truck crops and orchard. About 85 per cent of the total cash receipts is from livestock and livestock products and 12 per cent, from crops. Dairy products constitute the chief source of livestock receipts, and hogs are also a major source. Poultry, sheep, and beef cattle are less important sources. The average family labor earnings in 1935 were $1168.

METHOD OF STUDY

The study was conducted jointly by the Department of Rural Economics of the Ohio Agricultural Experiment Station and the Farm Management Unit of the Soil Conservation Service in Region 3. The data upon which this report is based were obtained by the survey method in the summer of 1936. Information was obtained from present owners and tenants, previous owners and tenants, and neighbors who had known the farm for a number of years. The informa-

tion given by neighbors was used as a check against that given by present operators. The information relative to soil types, slopes, and erosion was obtained from conservation surveys, and the data relative to incomes were obtained from farm management surveys made by the Soil Conservation Service.

This study portrays the condition on these farms previous to the time work was started in the various areas by the Soil Conservation Service. Information was secured from 100 farms. Forty of these farms were located in the Zanesville area, and 20 each, in the Wooster, Mt. Vernon, and Hamilton areas. The data were first tabulated by areas in order to determine in what respects one area differed from another. It was found that there was comparatively little difference, in the essential findings, between the areas. The data presented are, therefore, based upon the combined data of the four areas. In instances where the findings in one area differ materially from the findings in the other areas, this exception is noted.

The farms were selected by pairs. The members of each pair were similar in soil type and slope but differed in degree of erosion. The members of each pair of farms were in the same community; therefore rainfall is assumed to be similar. Since soil type, slope, and rainfall on the members of each pair were similar, the effects of these factors in causing differences in erosion were thus eliminated and the study was confined to factors other than these. The member of each pair showing the least erosion was designated as farm "A", and the member showing more severe erosion was designated as farm "B". The farms are so designated in the tables included in this text.

Detailed information relative to soil type, slope, cover, and erosion was available on these farms as a result of conservation surveys made by the Soil Conservation Service. In selecting the pairs of farms, careful attention was given to determine that the soils on each farm in the pair were practically identical. For this purpose the soils in each area were divided into five groups according to texture, structure, and the character of subsoil by the soil scientist of the Soil Conservation Service. Pairs of farms were selected in which one member had approximately the same percentage of land falling in each soil group as had the other. Although two pairs of farms might be dissimilar in soil type, the two members of each pair were practically identical and, therefore, comparable.

Table 1 shows the average percentage of land falling in each soil group. It will be noted that both groups of farms were practically identical as far as soils were concerned. We should, therefore, not expect to find a difference in erosion on these farms due to the soil factor.

TABLE 1.—Percentage of Farms in Various Soil Groups

Soil group*	A farms	B farms
	Pct.	*Pct.*
Group I	43	45
Group II	22	21
Group III	18	17
Group IV	5	5
Group V	12	12
Total	100	100

*In each area the soils were grouped by the soil scientist of the Soil Conservation Service according to texture, structure, and character of subsoil.

Likewise, the two groups of farms were similar in topography, as shown by the comparison of slope classes (Table 2). The slope classes used in this study are those set up by the Soil Conservation Service. They are designated by the letters A, B, C, and D. A slopes consist of level or slightly rolling land which can be tilled without serious damage from erosion. B slopes require special consideration of erosion-control methods if used for clean-tilled crops. This class is divided into B and BB; the BB slopes are steeper and require a greater use of control methods than the B slopes. C slopes are too steep to permit effective erosion control if used for clean-tilled crops and are best utilized for permanent meadow or pasture. D slopes should not be cultivated but should be used for trees or permanent pasture. Erodibility depends upon both soil type and slope and since soil type varies from area to area, the limits of the slope classes likewise vary from area to area.

TABLE 2.—Acreage on Farms in Various Slope Classes

Slope class*	Acres per farm		Per cent	
	A farms	B farms	A farms	B farms
A slope	24	19	19	17
B slope	54	47	42	41
BB slope	31	31	23	24
C slope	12	13	9	10
D slope	9	10	7	8
Total	130	120	100	100

*The limits of the slope classes in the four areas are as follows:

Zanesville:	A, 0-5%;	B, 5-12%;	BB, 12-20%;	C, 20-30%; D, over 30%
Wooster:	A, 0-3%;	B, 3- 7%;	BB, 7-15%;	C, 12-22%; D, over 22%
Mt. Vernon:	A, 0-3%;	B, 3- 7%;	BB, 7-12%;	C, 12-20%; D, over 20%
Hamilton:	A, 0-3%;	B, 3- 8%;	BB, 8-15%;	C, 15-25%; D, over 25%

It will be noted from the footnote to Table 2, for example, that a C slope in one area may be 20 per cent; whereas in another it may be only 12 per cent. Owing to difference in soil type, however, it is thought by the soil scientists that the 20 per cent slope in the one area will erode no more readily than will the 12 per cent slope in the other area. The limits of the slope classes, therefore, depend upon soil type, as well as degree of slope. Since both groups of farms were very similar in slope, the slope factor was evidently not a cause of the difference in erosion on these two groups of farms.

As previously stated, the members of each pair of farms were in the same community. In some cases they were adjoining farms and in no case were they more than 4 or 5 miles apart. Therefore, climate should be practically identical on these two groups of farms and we should not expect a difference in erosion due to climatic factors, such as the amount or intensity of rainfall.

However, as shown in Table 3, there was a wide difference in the degree of erosion which had occurred on these two groups of farms. A larger percentage of the land on the least eroded farms showed moderate sheet erosion and a smaller percentage, severe and very severe sheet erosion than was the case on the other group. Likewise, there was only about one-half as much gullying on the least eroded farms as on the more severely eroded farms. The problem was to find why the latter farms were more severely eroded when soil, topography, and climate were similar.

TABLE 3.—Acreage in Farms in Various Erosion Classes in 1935

Erosion class	A farms		B farms	
	Pct.	*Pct.*	*Pct.*	*Pct.*
1. No apparent erosion	10		8	
2. 0-25% of surface soil removed	36		22	
Total—moderate sheet erosion		46		30
3. 25-50% of surface soil removed	39		33	
33. 50-75% of surface soil removed	9		21	
Total—severe sheet erosion		48		54
4. 75-100% of surface soil removed	6		15	
5. Erosion of B and C horizons	0		1	
Total—very severe sheet erosion		6		16
Total sheet erosion		100		100
6. Slips	1		1	
7. Occasional gullies	3		6	
8. Frequent gullies	1		2	
9. Practically destroyed by gullies	0		0	
Total*—slips and gullies	5		9	

*Slips and gullies occur in combination with sheet erosion. Thus, a 27 erosion would be up to 25% of the surface soil removed and, in addition, occasional gullies.

Definite information was not available as to when this erosion took place or as to the comparative erosion on these two groups of farms 50 or 35 years ago. The data available gave the extent of erosion which had occurred to date. It was for this reason that an attempt was made to secure information on former, as well as present, uses and practices. A study of the farm buildings, 75 per cent of which exceed 35 years of age, shows that there was no significant difference in size or quality of these buildings when built, indicating that incomes were comparable at that time. An inspection of the areas at the time of the study showed that there was much active sheet erosion. Most of the gullies were also active. Although it was impossible to determine just when most of the erosion had occurred, it was the opinion of the enumerators, gained from interviews with the operators of these farms and especially with older residents in the communities, that much of the erosion had occurred within the past 35 to 50 years.

FACTORS RELATED TO EROSION

It is evident from this study, as well as from other farm management studies conducted in Ohio, that erosion may be affected by the physical layout or organization of the farm and by the methods of management or cultural practices used. Although it was found difficult to separate organization from management, an attempt has been made to group the results of the analysis under these heads.

LAND USE AND FARM ORGANIZATION

TYPE OF FARMING

The least eroded farms were slightly larger than the more severely eroded farms (Table 4). From 1900 to 1925 both groups of farms decreased their acreage of crops and increased their livestock. Between 1925 and 1935 the least eroded farms maintained their acreage of crops but made a slight decrease in the amount of livestock. The more severely eroded farms, how-

ever, decreased both crops and livestock. It is probable that because of accelerated erosion the owners of the latter group of farms found part of their cropland unprofitable and, therefore, were forced to reduce the crop acreage.

TABLE 4.—Acres in Farms, Acres in Crops, Percentage of Farm in Crops, and Animal Units per 100 Acres for Three Periods

	1900		1925		1935	
	A	B	A	B	A	B
Acres in farm	130	120	130	120	130	120
Acres in crops	73	72	66	65	66	61
Per cent of farm in crops	56	60	51	54	51	51
Animal units* per 100 A	14.6	14.2	17.8	16.1	16.8	14.7

*Animal unit—1 cow or horse, 2 young cattle or colts, 7 medium-wooled or 10 fine-wooled sheep, 14 to 20 lambs, 1400 pounds of hogs, 100 chickens.

Livestock production predominated on all areas. The trend on both groups of farms has been toward more livestock (Table 5). The least eroded group of farms, however, had more livestock and obtained a larger percentage of their receipts from livestock than did the more severely eroded farms. A livestock type of farming is more conducive to erosion control than is a cash crop type, since with livestock a larger proportion of the land is needed for pasture and meadow. These erosion-resisting crops can be grown on the steeper, more erosible land, and the more level land can be utilized for clean-tilled crops. The manure produced by livestock aids in maintaining organic matter and thus aids in erosion control. It seems probable that this difference in type of farming on these two groups of farms was responsible for some of the difference in erosion. The percentage of income from livestock increased from 1925 to 1935; whereas there was a slight decrease in livestock numbers (Tables 4 and 5). This seeming discrepancy can be explained by the difference in price relationships between livestock products and crops during these two periods and also, perhaps, by the increased productive capacity of livestock.

TABLE 5.—Percentage of Livestock and Crops Income Received from Livestock—1885, 1900, 1925, and 1935

Year	A farms	B farms
	Pct.	*Pct.*
1885	70	67
1900	71	66
1925	75	74
1935	80	77

TYPE OF COVER

Changes have also been made in the type of cover on these two groups of farms. In 1900 the more severely eroded farms had a larger percentage of their land in erosion-favoring crops than had the least eroded farms (Table 6). This higher percentage of erosion-favoring crops evidently contributed to erosion on these farms. As erosion resulted in low crop yields the operators of the more severely eroded farms retired poor cropland to pasture; whereas the operators of the less eroded farms maintained the same proportions which they had in 1900. As a result of this change both groups had the same proportion of their land in erosion-resisting crops by 1935.

TABLE 6.—Land Cover—1900, 1925, and 1935

Cover	1900		1925		1935	
	A	B	A	B	A	B
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Erosion resisting						
Meadow	23	23	19	19	18	18
Pasture	37	32	40	39	39	41
Woods and idle	7	8	9	7	10	8
Total	67	63	68	65	67	67
Erosion favoring						
Cereal crops	33	37	32	35	33	33

Whether the operators made these changes because of the force of economic necessity or because they realized the importance of erosion control was difficult to determine. Probably both factors affected their decision. In order to determine to what extent the operators recognized the seriousness of erosion, each was asked whether erosion was a problem on his farm and whether it was as severe now as in 1900 and 1925. Less than half of the operators of the less eroded farms considered erosion a serious problem; whereas over three-fourths of the operators of the other group recognized it as such (Table 7). The farmers' conception of erosion is primarily that of gullying. When they stated that erosion was not a problem, they probably meant that gullying was not a problem. It is, therefore, probable that the answers given to these questions by farmers apply primarily to gullying rather than to sheet erosion. It is true that erosion was a greater problem on the more severely eroded farms but it could hardly be said that it was not a problem on the less eroded farms, since 54 per cent of the land had lost more than 25 per cent of the surface soil and 6 per cent had lost from 75 per cent to all of the surface soil. It is probable that the organization and methods of farming employed on the less eroded farms had prevented as rapid acceleration of erosion as had occurred on the able that the organization and methods of farming employed on the less eroded farms said they were effectively controlling erosion and that erosion was now less severe than in 1900 or 1925. Only about 55 per cent of the operators of the more severely eroded farms considered erosion less severe now than in previous periods. Doubtless, these opinions do not give an accurate portrayal of conditions because of the farmer's conception of erosion and his unwillingness to admit that the land had depreciated under his management. It was the opinion of older neighbors in these areas, as well as of unbiased students, that sheet erosion is more severe on these farms now than at any previous period.

TABLE 7.—Farmers' Conception of the Status of Erosion

	A farms		B farms	
	Yes	No	Yes	No
	Pct.	*Pct.*	*Pct.*	*Pct.*
Is erosion a problem on your farm?	44	56	78	22
Is erosion as severe now as in 1925?	18	82	46	54
Is erosion as severe now as in 1900?	22	78	42	58

USE OF SLOPES

Since slope is a very important factor in erosion it is important to consider the distribution of cropland by slopes on the two groups of farms. The more severely eroded farms from 1885 to 1930 had a smaller percentage of their crops on A and B slopes and a larger percentage on BB, C, and D slopes than the other group (Table 8). Since 1931, both groups of farms have retired crops from C and D slopes and thus thrown a larger percentage of the crops onto A slopes (Tables 9 and 10). The less eroded farms of each pair had the better distribution of crops by slopes. Both groups had some of their crops on C and D slopes which, according to the Soil Conservation Service, are too steep for effective erosion control if cultivated. It appears, therefore, that the difference in the use of the various slopes was another factor causing difference in erosion on these two groups of farms.

TABLE 8.—Distribution of Cropland by Slopes, 1885-1930, and 1931-1935

Slope class	Acres per farm				Per cent			
	1885–1930		1931–1935		1885–1930		1931–1935	
	A	B	A	B	A	B	A	B
A	17	14	17	14	21	19	24	23
B	39	34	35	27	48	45	48	44
BB	19	19	17	16	23	25	23	27
C	6	6	3	3	7	8	4	5
D	1	2	1	1	1	3	1	1
Total	82	75	73	61	100	100	100	100

TABLE 9.—Percentage of Each Slope Cropped, 1885-1930, and 1931-1935

Slope class	1885–1930		1931–1935	
	A	B	A	B
	Pct.	*Pct.*	*Pct.*	*Pct.*
A	70	72	70	70
B	73	72	65	58
BB	61	61	54	53
C	48	47	28	24
D	12	19	5	7

TABLE 10.—Acres and Percentage of Cropland on Each Slope Class Retired Since 1885, by Slope Classes

Slope class	Cropland per farm retired since 1885		Per cent of cropland retired	
	A	B	A	B
	Acres	*Acres*		
A	0.2	0.5	1	3
B	4.3	6.5	11	19
BB	2.0	2.4	11	13
C	2.2	2.8	40	48
D	0.7	1.3	62	64

The question arises as to whether these operators are making full use of their more gentle slopes, whether they could shift crops from C and D slopes to A and B slopes, or whether the elimination of cropping on these slopes would

necessitate a reduction in crop acres. It is recognized that all of the A and B slopes are not suited for cultivation. In some cases A slopes may be poorly drained or subject to overflow. In other cases small areas of gently sloping land may be intermingled with steep land and thus, from the practical standpoint, unavailable for cultivation. Likewise, where small plots of C slopes are intermingled with large acreages of more gentle slopes it may be desirable, from the practical standpoint, to cultivate them even though it is recognized that erosion on these small plots cannot be effectively controlled. The operators are now cultivating only 60 to 70 per cent of their A and B slopes and are still cultivating 25 per cent of their C slopes. Evidently, all of the rather small acreage now on C and D slopes could be shifted to A or B slopes.

Both groups of operators had smaller acreages in crops in 1935 than in 1900. When a decision is made to retire land it would appear logical from the standpoint of erosion control that the steeper land be retired. It is evident that this was not always done, as more acres of A and B than of C and D slopes were retired. However, since there was only a small acreage of these steep slopes in cultivation, a small acreage retirement made a large percentage change (Table 10). It would have seemed more reasonable from the standpoint of erosion control to retire all of the steep slopes and a smaller percentage of the more gentle slopes.

QUALITY OF FARMING AND MANAGEMENT

KIND OF ROTATION

The methods of management and quality of farming employed by the operator, as well as the acreage distribution of land cover, may affect erosion. The rotation used is one of the important factors. According to information obtained by Erosion Experiment Stations, comparatively little erosion takes place when the land is in meadow; a moderate amount takes place under small grains; and erosion is severe in clean-cultivated crops. Therefore, a rotation which keeps a large proportion of the land in clean-cultivated crops is much more conducive to erosion than one in which there is a large proportion of meadow. A larger percentage of the least eroded than of the other farms employed erosion-resistant rotations (Table 11). During the past 35 years an

TABLE 11.—Percentage of Farms Using Various Crop Rotations—1900, 1925, and 1935

Rotation	1900		1925		1935	
	A	B	A	B	A	B
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Erosion-resistant rotations						
Corn, wheat, hay, hay, hay	18	8	5	4	7	3
Corn, wheat, hay, hay	22	25	19	6	15	14
Corn, wheat, hay	38	32	52	40	50	44
Total	78	65	76	50	72	61
Erosion-favoring rotations						
Corn, oats, wheat, hay	10	14	20	23	24	18
Corn, corn, wheat, hay	2	0	0	0	0	0
Corn, wheat	0	2	0	3	0	3
Corn, corn, soybeans	0	2	0	6	0	3
No definite rotation	10	17	4	18	4	15
Total	22	35	24	50	28	49

average of 75 per cent of the least eroded farms used erosion-resistant rotations as compared with only 59 per cent of the more eroded farms. This difference in kinds of rotations used was doubtless another reason for the variation in amount of erosion between the two groups.

USE OF FERTILIZER AND LIME

Since erosion is affected by the amount and quality of protective cover and since this in turn is affected by soil fertility, the amount of fertilizer or lime used is a factor in erosion control. In many cases lack of lime or fertilizer may result in only partial stands or even complete failure of a new seeding of meadow. In case of a partial stand, some erosion will take place in the poor meadow and only a poor sod will be available for turning under for the clean-tilled crop. In case of a complete failure it may be necessary to replant to a small grain crop or even to a clean-cultivated crop. In this case the protective cover may be eliminated entirely. The use of lime or fertilizer may thus be an extremely important factor.

A larger number of the least eroded than of the more eroded farms used fertilizer on wheat (Table 12). The former group also used approximately 40 per cent more fertilizer per acre than did the latter farms. This also applied to the fertilizer for corn. Although a smaller proportion of farmers in each group fertilized corn, the operators of the least eroded farms used 40 per cent more fertilizer per acre on corn than did the operators of the more eroded farms. The more universal use of fertilizer and the larger applications per acre on the least eroded farms doubtless aided in reducing erosion losses.

TABLE 12.—Number of Farms Using Fertilizer on Wheat and Average Application per Acre—1900, 1925, and 1935

	1900		1925		1935	
	A	B	A	B	A	B
Number using fertilizer	23	21	44	32	46	37
Number using no fertilizer	27	29	6	18	4	13
Average application per acre, lb.	68	61	159	103	169	121

Neither group of farms used lime to any great extent. The least eroded farms, however, had limed about twice as many acres as had the more eroded farms and had used, as a rule, larger applications per acre (Table 13).

TABLE 13.—Percentage of Crop Acres Limed and Rate of Application per Acre*

	Crop acres covered		Rate per acre	
	A	B	A	B
	Pct.	*Pct.*	*Lb.*	*Lb.*
1885–1899	0	0.2	0	50
1900–1924	8	6.0	620	380
1925–1935	13	7.0	680	760

*Average of Zanesville, Mt. Vernon, and Wooster areas. No lime used on farms studied in Hamilton area.

OTHER FACTORS

Other factors shown by the Erosion Experiment Stations to affect the rate of erosion are contour cultivation, terracing, and strip-cropping. No terracing or strip-cropping was practiced on the farms included in this study. Cultivation approximately on the contour was practiced by some farmers; whereas others paid little or no attention to contour cultivation. There was but little evidence, except in the Zanesville area, that the operators of the least eroded farms had practiced contour cultivation to any greater extent than had the operators of the more eroded farms.

There are many other things, such as leaving grassed waterways in cultivated fields, stopping small gullies, and judicious grazing of pastures, which one may do to check erosion, especially in its incipient stages. No information was obtained in this study as to what extent these other practices were employed on these two groups of farms. The employment of such practices depends to a considerable extent upon the foresight, initiative, and management ability of the operator. Since the operators of the least eroded farms showed superior management ability in other respects it is reasonable to assume that they employed many of these other methods of controlling erosion to a greater extent than did the operators of the more eroded farms.

TENURE AND MORTGAGE DEBT

Land tenure also may be a factor in erosion. It is usually true that a tenant, especially one who has only a short-term lease, is not as much interested in erosion prevention as is an owner-operator. He is interested primarily in obtaining the maximum immediate income from the land and frequently gives but little attention to erosion control or the maintenance of soil productivity. Furthermore, because of limited finances or because most farms available for rent are not equipped for livestock production, he probably has but little livestock and, therefore, practices a cash crop type of farming in which a large proportion of the farm is devoted to cash crops which are in most cases erosion permitting. Under these conditions he is not interested in using a rotation which would include a large acreage of hay. Neither does he need a large acreage of pasture. Owing to limited finances he may use but little fertilizer and, in the absence of a long lease, probably no lime. Furthermore, the landlord, especially if he is an absentee landlord, may not realize the seriousness of erosion and may not encourage or assist the tenant in effecting erosion-control measures. Thus, tenancy, especially short-term tenancy, may be an important factor in erosion.

The length of ownership per individual owner and the intent of ownership may be other important factors in erosion. An owner who holds land for speculation or who has been forced to acquire land through mortgage foreclosure and desires to sell it as soon as possible is frequently but little interested in erosion prevention. He probably favors a short-term tenancy contract so that he can give possession to the land at any desired time. Since crops are more easily divided than livestock or livestock products, he favors a cash crop rather than a livestock type of farming. If he expects to own the land for only a short period of time, he is not interested in making expenditures for lime or for other soil-building practices. Thus, the intent of ownership may have an important bearing on erosion.

Twenty of the 50 least eroded farms were continuously owner operated as compared with only 13 of the more eroded farms (Table 14). Thirteen of the former farms were tenant operated for less than 10 years, compared with 11 of the more eroded farms. A smaller number of the least eroded farms than of the more eroded farms were tenant operated for 10 years or more.

TABLE 14.—Number of Farms by Tenancy Groups, 1885-1935

Tenancy group	A farms	B farms
	No.	*No.*
No tenancy	20	13
1- 9 years of tenancy	13	11
10-19 years of tenancy	8	14
20-29 years of tenancy	2	3
30 years or more of tenancy	7	9
Total	50	50

There was a more rapid change in tenure on the more eroded farms than on the least eroded farms. There were 213 owners of the 50 more eroded farms during the past 50 years as compared with only 183 owners of the 50 least eroded farms (Table 15). The average term of ownership of the more eroded farms was, thus, only 11.5 years as compared with 13.5 years on the least eroded farms. Likewise, there were more tenants and a shorter term of occupancy per tenant on the former group of farms; the tenant occupied the farm for an average of only 3.4 years as compared with 5.2 years on the latter group. It is probable that the more rapid change of ownership, the increased amount of tenancy, and the shorter period of tenancy on the more eroded farms were factors contributing to erosion.

TABLE 15.—Land Tenure, 1885-1935

	50 A farms	50 B farms
Number owners	183	213
Number tenants	108	208
Number operators	267	396
Years of tenancy	575	725
Years of share tenancy	505	662
Years of cash tenancy	70	63

The owner's financial condition may be another factor affecting erosion. He may be financially unable to purchase the needed amounts of lime, fertilizer, or seed or to make other expenditures for erosion control. Again, he may be so burdened with debt as to discourage him and cause him to lose interest in the farm. Low income may, therefore, in many cases be a contributing factor to, as well as a result of, erosion. Information relative to assessed valuation and mortgage debt of these farms was obtained from county records. A larger number of the more eroded farms were mortgaged than was the case with the least eroded farms. Most of the mortgages were of long standing (Table 16).

TABLE 16.—Percentage of Farms Mortgaged—1890, 1910, and 1934*

Year	A farms	B farms
	Pct.	*Pct.*
1890	40	54
1910	56	64
1934	48	52

*Source: county records.

There was but little difference in the average assessed value of these two groups of farms (Table 17). It will be noted that in 1890 the more eroded farms were assessed for slightly more per acre than were the less eroded farms; whereas in 1934 the reverse was true. Whether the difference in the trend in the assessed value per acre of these two groups of farms was due to changes in productive capacity or sales value due to erosion was impossible to determine. The indebtedness per acre on the more eroded farms, however, was larger than that on the less eroded farms, making the indebtedness per acre in proportion to assessed value much larger on the former farms. In 1910 both groups of farms were mortgaged for more than their assessed value. By 1934 the least eroded farms had reduced their debt to 78 per cent of the assessed value; whereas the debt on the more eroded farms was still 15 per cent above the assessed value. It is probable that because of the heavier debt burden the owners of the more eroded farms were unable to practice erosion-control measures to the same extent as were the owners of the least eroded farms.

TABLE 17.—Assessed Value, Indebtedness, and Relationship of Indebtedness to Assessed Value on Mortgaged Farms—1890, 1910, and 1934*

Year	Assessed value per acre		Indebtedness per acre		Per cent indebtedness is of assessed value	
	A	B	A	B	A	B
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Pct.*	*Pct.*
1890	29	31	18	24	62	77
1910	27	27	27	33	100	127
1934	35	34	27	42	78	115

*Source: county records.

RESULTS OF EROSION

Differences in erosion might result in differences in crop yields, differences in farm income, and, as a result of differences in income, in differences in living conditions.

Since corn was the most universally grown crop on these farms, the yield of corn was taken as being indicative of the productive capacity of the land. As shown in Table 18, corn yields on the least eroded farms were about 25 per cent above those on the more eroded. It will also be noted that corn yields on the least eroded farms increased from 1900 to 1935; whereas yields on the more eroded farms decreased. There was, thus, a wider spread in yields in 1935 than in 1900, indicating that the productive capacity of the land on the more eroded farms had declined more rapidly than that of the least eroded farms. The trend in crop yields from year to year may not be a true measure of the

productive capacity of the land, since it is affected by varieties, cultural practices, and the soil upon which the crop is planted. One may, for example, maintain a yield of 40 bushels of corn by reducing corn acreage and retiring all land which will not produce that much. It is known that much of the badly eroded land on these farms was retired during the period covered by the study. However, since the more eroded farms retired more land than did the less eroded farms (Table 10), they had a greater opportunity of maintaining yields through the elimination of low-producing fields. It is probable, therefore, that the difference in productive capacity of these farms widened even more during the period than indicated by corn yields.

TABLE 18.—Yield per Acre of Corn—1900, 1925, and 1935

Year	Yield per acre			
	A farms	B farms	Difference	
	Bu.	*Bu.*	*Bu.*	*Pct.*
1900	40	36	4	11
1925	42	33	9	27
1935	43	35	8	23

Differences in erosion may result in differences in income. It is recognized that there are many factors affecting incomes other than the organization and management factors considered in this study. For example, the productive capacity of livestock or the methods of feeding, care, and management may affect incomes greatly. It was found that the dairy cattle on the least eroded farms produced an average of $66 worth of products per cow as compared with only $56 on the more eroded farms. This, as well as other factors, would indicate more careful management on the least eroded farms.

Family labor earnings on the least eroded farms were 65 per cent greater than those on the more eroded farms (Table 19). It is evident that there was a relationship between erosion and income. Low incomes may be either a result or a contributing cause of erosion. Severe erosion may result in low incomes and low incomes may prevent the establishment of erosion-control practices and thus result in erosion. It is, therefore, impossible to state definitely whether low incomes were a result or a cause of erosion.

TABLE 19.—Income per Farm*, 1934

	A farms	B farms
	Dol.	*Dol.*
Farm income	1187	774
Labor income	856	527
Labor earnings	1217	796

*Average of Zanesville, Mt. Vernon, and Wooster areas. Income data not available for Hamilton area.

Differences in erosion, through their effects on income, may result in differences in living conditions. There was but little difference in the size of houses and barns on these two groups of farms (Table 20). About 75 per cent of the houses and barns on both groups of farms had been built previous to 1900. As far as could be observed by the enumerators, there was no difference in the

type of construction or quality of buildings when built. Evidently, at one time housing facilities on these two groups of farms were similar. At the time the study was made the buildings were classed by the enumerators as good, fair, or poor, depending largely upon their state of repair. A larger percentage of both houses and barns on the least eroded farms was classed by the enumeration as good, and a smaller percentage, as fair or poor than was the case on the more eroded farms.

TABLE 20.—Average Size and the Condition of Buildings, 1935

	House		Barn	
	A	B	A	B
	No.	*No.*	*No.*	*No.*
Number of rooms	7.4	7.5	.....	.....
Square feet of floor space	.....	.....	2512	2805
Good condition	30	19	21	15
Fair condition	12	22	17	18
Poor condition	8	9	12	17

SUMMARY AND CONCLUSIONS

This study would indicate that under Ohio conditions there are a number of factors within the control of man which contribute to erosion. Studies of individual case histories indicate that on a particular farm certain factors within the control of man appear to be dominant causes; whereas others are less important, and that on other farms some of these less important factors appear to be dominant. It is probable that similar studies conducted in other areas having different conditions would indicate factors in addition to those discussed in this study. Since it was apparent that no one factor was a dominant cause on a large majority of the farms, no attempt was made to determine the relative importance of the factors. That many of the factors are interrelated and must be considered in their relationship to other factors is probably one of the most outstanding findings of the study. Since there is no one outstanding cause of erosion on all farms, there is likewise no one outstanding remedy. Changes in land use or the establishment of single control practices, such as terracing or strip-cropping, may aid in controlling erosion but would evidently not constitute a complete erosion-control program for all farms. The present practices prevailing on many of the farms were as frequently a result of past erosion as they were a factor leading to current erosion. In an erosion-control program all the factors associated with erosion should be considered. This study points out the importance of quality of farming and management, as well as organization and land use, as factors in erosion control.

Some of the chief factors which should be considered in erosion control as shown by the study are as follows:

Erosion is associated with type of farming. The less eroded farms had more livestock and less cash crops than did the more severely eroded farms. The possibility of a livestock type of farming should, therefore, be given consideration.

Erosion is associated with the proportions of the land devoted to clean-cultivated crops, close-growing crops, and woods. The less eroded farms had a larger percentage of their land in erosion-resisting crops, such as meadow, pasture, and woods, than did the more severely eroded farms. Type of cover is an important item in erosion control.

Erosion is associated with use of land by slope classes. The less eroded farms had a larger percentage of their cultivated crops on the more gentle slopes and a smaller percentage on the steeper slopes than did the more severely eroded farms. The use of land by slope classes deserves consideration.

Erosion is associated with the kind of rotation used on the cropland. The less eroded farms used rotations containing a larger percentage of erosion-resisting crops and a smaller percentage of clean-cultivated crops than did the more severely eroded farms.

Erosion is associated with the amount of lime and fertilizer used. The less eroded farms used lime and fertilizer on a larger percentage of their cropland and also used larger applications per acre than did the more severely eroded farms.

Erosion is associated with land tenure. There were a lower percentage of tenancy, a longer period of occupancy per tenant, and a longer period of ownership per owner on the less eroded farms than on the more severely eroded farms.

Erosion control is associated with good farm practices. A grass cover may be ruined by overgrazing or a seeding may fail because of poor seedbed preparation or untimely seeding.

Erosion is associated with the owner's financial condition. A smaller percentage of the less eroded farms was mortgaged, and the mortgage indebtedness per acre was smaller on the less eroded farms than on the more severely eroded farms. A lightening of the mortgage indebtedness would evidently assist in the solution of the problem.

Some of the results of erosion as indicated by the study are as follows:

Erosion reduces crop yields. Yields of corn on the less severely eroded farms were 25 per cent above those of the more severely eroded farms. Furthermore, the less severely eroded farms had maintained crop yields; whereas yields per acre had declined on the more severely eroded farms.

Incomes were 65 per cent larger on the less eroded farms than on the more severely eroded farms. Low incomes may be a result of erosion. They may also be a contributing cause through preventing the establishment of erosion-control measures.

Erosion affects buildings and living conditions. The majority of the buildings on the less eroded farms were maintained in good condition; whereas the majority of the buildings on the more severely eroded farms were in poor or fair condition.